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(71) Applicant: MITSUBISHI DENKI KABUSHIKI KAISHA
2-3, Marunouchi 2-chome
Chiyoda-ku
Tokyo(JP)

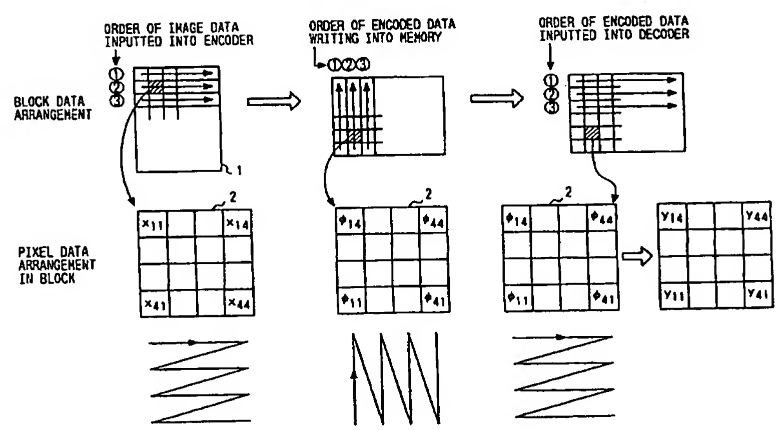
(72) Inventor: Oka, Kenichiro, c/o Mitsubishi Denki K.K.
Fukuyama Seisakusho,
1-8 Midori-machi
Fukuyama-shi, Hiroshima(JP)

(74) Representative: KUHNEN, WACKER & PARTNER
Alois-Steinecker-Strasse 22
D-85354 Freising (DE)

(54) **Image encoding method and image encoding/decoding method.**

(57) An encoding method of a GBTC type that encoded data and decoded data have a fixed length, which can reduce the degree of deterioration of the quality of a reproduced image and also to provide an encoding/decoding method which, in encoding or decoding, is capable of performing editing processings to rotate an original image in 90° and to rotate it inversely with respect to up and down, right and left. When encoded data in each of blocks of an original image and level specification signals ϕij of respective pixels in each block are written into a memory or are read out therefrom, the fractions of parameter values are rounded to the nearest whole number or cut away to thereby put operation values into integral numbers, or the encoded data and the pixel level specification signal are arranged in such a manner that they can be rotated or inversely rotated an integral number of times 90°.

FIG. 3



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BACKGROUND OF THE INVENTION

The present invention relates to an image encoding method which is suitable for processing an image having multi-tone gradations as well as an image encoding/decoding method which is capable of editing an image while it is encoded data.

As a conventional block truncation encoding method which divides image data into a plurality of blocks each consisting of a plurality of pixels and approximates the image data by a small number of representative gradations in each of the blocks, for example, there is known a method which is disclosed in Unexamined Japanese Patent Publication (Kokai) Hei-1-188166.

The procedures of the conventional encoding method are as follows:

(1) An image is divided into a plurality of blocks each consisting of a plurality of pixels.

(2) In each block, there is found a difference D between the maximum value of gradation levels Lmax and the minimum value thereof Lmin, that is, D=Lmax-Lmin, and the resultant differences D are classified into the following three kinds of encoding modes:

Mode A: when D is small;
Pixels in the block are quantized to 1 level.

Mode B: when D is comparatively large;
Pixels in the block are quantized to 2 level.

Mode C: when D is large;
pixels in the block are quantized to 4 level.

(3) When the quantized level is 1 level, then an average value is used; when 2 level, then the respective representative values of a pixel group larger than the average value and a pixel group smaller than the average value are used; and, when 4 level, then 4 values at regular distances and corresponding to gradation distributions in the block are used.

(4) Each of the blocks is designated by a reference level La for regulating the quantization level in the block, a level distance Ld, and a level specifying signal (2 bits/pixel) for regulating a quantization level for every pixel.

(5) The level specifying signal is connected between the blocks to be converted into two bit plane images ($\phi 1$, $\phi 2$), and are then encoded by use of binary image codes such as MMR (CCITT/T. 6) or the like, respectively. Also, the level distance Ld is encoded by use of a variable length code, and the reference level La encodes a difference between the blocks by use of a variable length code.

Also, according to the conventional encoding method, there are employed the following several means in order to enhance an encoding efficiency:

(1) The encoding modes are classified into 3 kinds according to the differences between the maximum and minimum values of the gradation level of the pixels in each of the blocks to change the quantizing level number.

(2) The level specifying signal is converted into the two bit plane images and the two bit plane images are respectively encoded in terms of codes for binary images.

(3) The level distance Ld is encoded in terms of a variable length code.

(4) The reference level La encodes a difference between the blocks by use of a variable length code.

In the variable length codes encoded in a block unit in this manner, the code data length thereof varies in the respective blocks. Therefore, it is difficult to take out an arbitrary block from the code data group for the purpose of image editing. Further, due to the fact that the reference level La is encoded by a difference between the blocks in a variable length code, even if only the codes in an arbitrary block are taken out, they cannot be decoded but the codes must be decoded sequentially from the first block in the same order as they are encoded.

As an encoding method to solve the above problems, there is known an encoding method of a GBTC (Generalized Block Truncation Coding) type which is disclosed in the draft of a meeting for reading papers of the Institute of Image Electronics Engineers of Japan, "evaluation of an image compression method in a hard copy device" 1991-04-01. Description will be given below of this encoding method.

In Fig. 5, there is shown an explanatory view of the above encoding method of a GBTC type. In Fig. 5, reference character 1 designates an original image; 2, a block which is composed of a square consisting of 4×4 pixels; Xij (i, j = 1, 2, 3, 4), a piece of pixel data (which will be hereinafter called "Xij"); and ϕij (i, j = 1, 2, 3, 4), a level specification signal (which will be hereinafter referred to as "ϕij").

In Tables 1 and 2, there are shown an algorithm of a conventional GBTC type encoding method in which encoded data respectively have a fixed length.

[TABLE 1]

GBTC type encoding algorithm

```
P1 = (Lmax + 3Lmin)/4
P2 = (3Lmax + Lmin)/4
Q1 = mean value of all Xij (Xij ≤ P1)
Q4 = mean value of all Xij (Xij > P2)
La = (Q1 + Q4)/2
Ld = Q4 - Q1
L1 = La - Ld/4
L2 = La + Ld/4
for (i = 1, 2, 3, 4)
  for (i = 1, 2, 3, 4)
    if Xij ≤ L1              φij = 01 (binary)
    else if Xij ≤ La         φij = 00 (binary)
    else if Xij ≤ L2         φij = 10 (binary)
    else                     φij = 11 (binary)
    end if
  end for
end for
```

[TABLE 2]

GBTC type decoding algorithm

```
for (i = 1, 2, 3, 4)
  for (i = 1, 2, 3, 4)
    if φij = 01              Yij = La - Ld/2
    else if φij = 00         Yij = La - Ld/6
    else if φij = 10         Yij = La + Ld/6
    else                     Yij = La + Ld/2
    end if
  end for
end for
```

Fig. 6 is a block circuit diagram of a signal process system using the above encoding method, in which reference numeral 3 designates a host device; 4, an encoding circuit; 5, a decoding circuit 5; and 6, an image data memory (which will be hereinafter called a memory).

Also, Fig. 7 is a block circuit diagram of the encoding circuit 4, in which reference numeral 7 designates a buffer memory; 8, an encoding operation circuit; 9, a reference level buffer; 10, a level interval buffer; 11, a level specification signal buffer; and 12, a signal control circuit.

Next, description of the encoding method will be given below. In the conventional encoding method, it is assumed that the pixel data Xij is composed of 1 byte. The original image 1 is divided into blocks 2 each consisting of 4×4 pixels, and each of the blocks is then encoded. That is, at first, it is divided between the maximum value Lmax and minimum value Lmin pixels in each block 2 into four equal parts, in which at quarter value from the bottom is expressed as P1 while a quarter value from the top is expressed as P2. Next, the average value of pixels values ranging from Lmin up to P1 is expressed as Q1, while the mean value of pixel values ranging from Lmax down to P2 is expressed as Q4.

Then, the reference level La of the block is found according to the following equation:

$$La = (Q1 + Q4)/2$$

And, the level interval Ld is found according to the following equation:

$Ld = Q4 - Q1$

After then, the level interval Ld is divided into four equal parts, in which a quarter value from the bottom is expressed as L1 while a quarter value from the top is expressed as L2. Next, with L1, La and L2 as the threshold values thereof, 16 pixels within the block are respectively quantized in the following manner:

When $Lmin \leq xij \leq L1$, $\phi ij = 01$ (binary value);
When $L1 < xij \leq La$, $\phi ij = 00$ (binary value);
When $La < xij \leq L2$, $\phi ij = 10$ (binary value);
When $L2 < xij \leq Lmax$, $\phi ij = 11$ (binary value).

Now, description will be given below of the operation of the encoding circuit 4 with reference to Figs. 7 and 8. In Fig. 7, the image data corresponding to 4 lines is once stored in the buffer memory 7 and are then transmitted to the encoding operation circuit 8 by blocks, in which La, Ld, and $\phi 11$ to $\phi 44$ are found according to such a procedure as described above. The thus found La, Ld and $\phi 11$ to $\phi 44$ are then sent respectively through the reference level buffer 9, level interval buffer 10 and level specification signal buffer 11 to the signal control circuit 12, in which they are collected as code data by blocks as shown in Fig. 8.

The code data is written in the memory 6 in the form of a code system arranged in such a manner as shown in Fig. 8. If 1 byte is allocated to La, 1 byte is allocated to Ld, and 2 bits are allocated to each of $\phi 11$ to $\phi 44$, then the length of the encoded data belonging to 1 block is 6 bytes. In this manner, the code length of each block is a fixed length of 6 bytes, so that it is simple to take out the code data of an arbitrary block from the code system.

Fig. 9 is a block diagram of the decoding circuit 5 shown in Fig. 6, in which reference numeral 14 stands for a signal distribution circuit; 15, a reference level buffer; 16, a level interval buffer; 17, a level specification signal buffer; 18, a decoding operation circuit; and 19, a buffer memory, respectively.

Fig. 10 is an explanatory view of a conventional GBTC type decoding method shown in Table 2, in which reference character yij (i, j = 1, 2, 3, 4) stands for decoded pixel data.

Next, the conventional decoding method will be described below. In this method, as shown in Fig. 10, a piece of encoded data is composed of La, Ld, and ϕij. On the basis of these parameters, the following operation is performed to thereby find the decoded pixel data yij.

When $\phi ij = 01$, then $yij = La - Ld/2$
When $\phi ij = 00$, then $yij = La - Ld/6$
When $\phi ij = 10$, then $yij = La + Ld/6$
When $\phi ij = 11$, then $yij = La + Ld/2$

Next, description will be given below of the operation of the decoding circuit 5. In Fig. 9, encoded data in 1 block are divided by the signal distribution circuit 14 into La, Ld, and $\phi 11$ to $\phi 44$, the three kinds of signals are respectively distributed to the reference level buffer 15, level interval buffer 16, and level specification signal buffer 17, the decoded pixel data yij is computed by the decoding operation circuit 18, the decoded pixel data yij is written into the buffer memory 19 every block, and the decoded pixel data yij is outputted every 4 lines.

In the conventional GBTC type encoding method employing a fixed code length, there are produced fractions in an operation to find the respective parameters P1, P2, La, Ld, L1 and L2 for use in encoding and in an operation to find the decoded pixel data yij for use in decoding. For this reason, when the conventional method is used to repeat encoding and decoding processings on the same image data, the encoded data and decoded data continue to vary each time the processings are performed, with the result that, when the data are reproduced as an image, the quality thereof continues to deteriorate.

SUMMARY OF THE INVENTION

The present invention aims at eliminating the above problems found in the conventional GBTC type encoding method. Accordingly, it is an object of the invention to provide a GBTC type encoding method employing a fixed code length which can restrict the deterioration of the quality of the reproduced image from an original image to a small range even if encoding and decoding processings are performed repeatedly.

It is another object of the invention to provide an encoding/decoding method which, in encoding or decoding, is able to perform an editing processing to rotate an image in 90° unit or an editing processing to turn the image upside down or turn inversely the right and left of the image.

The image encoding method of the invention is an encoding method of a fixed length GBTC type, in which fractions to be produced in an operation to encode or decode an image are rounded to the nearest

whole number or cut away to thereby arrange all parameters and signals into integral numbers.

In the image encoding/decoding method according to the invention, in encoding, the encoded data in each of the blocks and the level specification signals of the respective pixels in each of the blocks are arranged in a memory in such a manner that they can be respectively rotated forwardly or inversely by an integral number of times 90° according to cases.

Also, in decoding, when the encoded data of the respective blocks and the level specification signals of the respective pixels in each of the blocks are taken out from the memory, they are respectively read out so that they can be arranged in such a manner that they can be rotated forwardly or inversely an integral number of times 90°.

According to the image encoding method of the invention, due to the fact that fractions to be produced in the encoding and decoding operations are rounded to the nearest whole number or cut away to thereby arrange the respective parameters and the level specification signals of the respective pixels in each of the blocks into integral numbers, when encoding and decoding processings are performed repeatedly on the same image data, encoded data and decoded data are converged at the third encoding or decoding processing at the latest, respectively.

Also, in the image encoding/decoding method of the invention, in encoding, the code data and the level specification signals in the respective blocks are arranged in such a manner that they can be rotated forwardly or inversely an integral number of times 90° according to cases, which makes it possible to edit an image in encoding.

Further, in decoding, the code data and the level specification signals in the respective blocks are arranged in such a manner that they can be rotated forwardly or inversely an integral number of times 90° according to cases, which makes it possible to edit an image in decoding.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory view of a case in which the coded data reaches its converged condition at the third encoding processing in an encoding method according to the embodiment 1 of the invention;

Fig. 2 is an explanatory view of a case in which the decoded data reaches its converged condition at the second decoding processing in an encoding method according to the embodiment 2 of the invention;

Fig. 3 is an explanatory view of a case in which an image editing processing is executed at the encoding stage of the embodiment 2 of the invention;

Fig. 4 is an explanatory view of a case in which an image editing processing is executed at the decoding stage of the embodiment 3 of the invention;

Fig. 5 is an explanatory view of an conventional encoding method of a fixed length GBTC type;

Fig. 6 is a block diagram of an encoding/decoding circuit using the conventional encoding method of a fixed length GBTC type;

Fig. 7 is a block diagram of an encoding circuit using an encoding method of a fixed length GBTC type;

Fig. 8 is an explanatory view of the arrangement of the respective parameters and level specification signals as well as the code system in reading according to the encoding method of a fixed length GBTC type;

Fig. 9 is a block diagram of a decoding circuit using an encoding method of a fixed length GBTC type; and,

Fig. 10 is an explanatory view of a decoding method of a fixed length GBTC type.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiment 1

In Tables 3 and 4, there is shown an algorithm employed in the GBTC type encoding method of the invention.

[TABLE 3]

GBTC type encoding algorithm in Embodiment

```
P1 = (Lmax + 3Lmin)/4    (fractions to be rounded to the
                         nearest whole number or cut
                         away)
P2 = (3Lmax + Lmin)/4    (fractions to be rounded to the
                         nearest whole number or cut
                         away)
Q1 = mean value of all Xij (Xij ≤ P1)
                  (fractions to be rounded to the
                  nearest whole number or cut away)
Q4 = mean value of all Xij (Xij ≥ P2)
                  (fractions to be rounded to the
                  nearest whole number or cut away)
La = (Q1 + Q4)/2  (fractions to be rounded to the
                  nearest whole number or cut away)
Ld = Q4 - Q1
L1 = La - Ld/4    (fractions to be rounded to the
                  nearest whole number or cut away)
L2 = La + Ld/4    (fractions to be rounded to the
                  nearest whole number or cut away)
for (i = 1, 2, 3, 4)
  for (i = 1, 2, 3, 4)
    if Xij ≤ L1          φij = 01 (binary)
    else if Xij ≤ La     φij = 00 (binary)
    else if Xij ≤ L2     φij = 10 (binary)
    else                 φij = 11 (binary)
    end if
  end for
end for
```

[TABLE 4]

GBTC type decoding algorithm

```
for (i = 1, 2, 3, 4)
  for (i = 1, 2, 3, 4)
    if φij = 01              Yij = La - Ld/2
                          (fractions to be rounded to the
                          nearest whole number or cut away)
    else if φij = 00         Yij = La - Ld/6
                          (fractions to be rounded to the
                          nearest whole number or cut away)
    else if φij = 10         Yij = La + Ld/6
                          (fractions to be rounded to the
                          nearest whole number or cut away)
    else                     Yij = La + Ld/2
                          (fractions to be rounded to the
                          nearest whole number or cut away)
    end if
  end for
end for
```

The algorithm of the present encoding method is different from the algorithm of the conventional encoding method shown in Tables 1 and 2 in that Q4 is the mean value of pixel values which range from Lmax down to P2 and also that, when there are produced fractions in the operation values used to find the parameters P1, P2, Q1, Q4, La and yij, the fractions are rounded to the nearest whole number or cur away to thereby arrange the respective values into integral numbers respectively. Such integral number arrangement processings are performed by means of the encoding circuit and decoding circuit.

In Fig. 1, there is shown an example in which, when the encoding and decoding processings are repeatedly performed on the same image data in the encoding method according to the embodiment 1, the image data reaches a converged condition. In Fig. 1, reference characters 24a and 24b designate encoded data; 25a and 25b, decoded image; 26, converged encoded data; and 27, a converged decoded image, respectively. In this case, at first the encoded data 26 is converged and then the decoded image 27 is also converged. After once converged, even if encoding and decoding processings are performed again on the same image data repeatedly, no further quality deterioration will occur at all. For this reason, after converged, the present encoding method is substantially equivalent to a reversible encoding method.

In Fig. 2, there is shown an example in which the image data reaches its converged condition at the second decoding processing. In this case, at first the decoded image 27 is converged and then the encoded data is also converged.

Embodiment 2.

In Fig. 3, there is shown another embodiment, namely, embodiment 2 of an image encoding/decoding method according to the invention in which an operation of editing an image is executed at an encoding stage, specifically in this case, by rotating the image to the left 90°. In writing the encoded data into the memory 6, the encoded data are not written in the order that they are inputted, but the data are rearranged in such a manner that the 90° left rotation editing is included. In particular, the mutual data arrangement between blocks is made in such a manner as shown in Fig. 3. That is, in writing into the memory 6 the encoded data of an original image that are sequentially inputted by scanning the image from left top to the right direction, from top down to bottom, the data are rearranged sequentially by scanning the image from left bottom to the upper left direction, from left to right, before they are written into the memory 6. Similarly, φij are rearranged in such a manner as shown in Fig. 3. When decoding the encoded data arranged in the above manner, if they are decoded in a normal manner, that is, if they are read out sequentially by

scanning the image from left top to the right direction, from top to bottom, then the reproduced image is rotated left 90° relative to its original image.

To rotate the original image left 180°, the figures of Fig. 3 may be rotated left further 90° and, in this arrangement, the block data and pixel data may be written into the memory 6 and then the data may be read out in the same order as shown in the right-most figures. And, to rotate the original image left 270°, the figures of Fig. 3 may be rotated left 180°.

In the embodiment 2, there is shown a case in which an image is rotated left an integral number of times 90°. However, the invention is not limited to this, but it can similarly apply to other cases in which the image is rotated right or is turned upside down or vice versa. Further, the invention can similarly apply to an editing processing which includes a combination of the image right and left rotation with the up-and-down and right-and-left inversed rotations.

Embodiment 3

In Fig. 4, there is shown a still further embodiment, that is, embodiment 3 according to the invention, in which an image editing processing is executed at a decoding stage. Specifically, in the embodiment 3, there is shown a case in which an original image is rotated left 90°. In the embodiment 3, when reading out the encoded data from the memory 6, the encoded data are not read out in the order that they have been written there, but the data are to be rearranged in such a manner that a 90° left rotation editing can be included. Concretely, the mutual data arrangement between the blocks is changed in such a manner as shown in Fig. 4. That is, in writing, the encoded data are inputted in the order that the image is scanned sequentially from left top to the right direction, from top to down, while in reading the data are rearranged by scanning sequentially from right top to the downward direction, from right to left. The pixel data ϕij are similarly rearranged as shown in Fig. 4. If the thus read-out encoded data are decoded, then the reproduced image is found that it is rotated 90° with respect to its original image.

To rotate an original image left 180°, 270°, and to rotate it inversely with respect to up and down and right and left, the data of the original image may be read out from the memory 6 by changing the image scanning order.

In the above-mentioned embodiments, each of the blocks is considered as a square having 4×4 pixels. However, the shape and number of pixels of each block are not limited to this. In this case, the buffer memory 7 for storing the data before encoded and the buffer memory 19 for storing the data after encoded may be respectively constructed such that they have the number of lines that matches the size of the block.

Also, although in the embodiments, the amount of data of 1 pixel is 8 bits, the data amount may be different. Further, the reference level La and level interval Ld are respectively allocated 1 byte and level specification signals $\phi 11$ to $\phi 44$ are respectively allocated 2 bits. However, other different arrangements may be employed for fixing the length of the codes.

To the memory 6 in the encoding/decoding device shown in Fig. 6, there can be applied a secondary storage medium such as a semiconductor memory, a magnetic disk or the like. Also, as a system which uses the present encoding method, there is available an image data base or the like.

In Fig. 6, the encoding circuit 4 and decoding circuit 5 are disposed externally of the memory 6. However, they can be incorporated integrally in the memory 6. Also, both of the encoding circuit 4 and decoding circuit 5 may be incorporated in the host device 3.

In the embodiments 2 and 3, there is shown a case in which an image is rotated left an integral number of times 90°. However, the invention is not limited to this but it can similarly apply to right rotation, up-and-down inverted rotation, right-and-left inverted rotation and the like. Further, the invention can similarly apply to an editing processing which combines the right and left rotation with the up-and-down and right-and-left inverted rotations.

As has been described heretofore, according to the invention, there is provided an image encoding method in which the data length is fixed with respect to the reference level signal, level interval signal and level specification signal and, as the whole of the codes, every block has a fixed length. In the present image encoding method, due to the fact that the fractions of the operation values of the respective parameters for use in encoding as well as the fractions of the level specification signals values of the respective pixels in the blocks calculated in decoding are rounded to the nearest whole number or cut away, when encoding and decoding processings are performed repeatedly on the same image data, the encoded data and decoded data are respectively converged at the third encoding or decoding processing at latest. Thanks to this, even if the encoding and decoding processings are performed repeatedly, the quality of the reproduced image can be restricted to a small range of deterioration when compared with the quality of the original image.

Also, according to the image encoding/decoding method of the invention, in ncoding, the coded data in the respective blocks and the level specification signals of the respective pixels in the respective blocks to be written into the memory are arranged such that the coded data and specification signals can be respectively rotated or inversely rotated an integral number of times 90°, which makes it possible to edit an image in encoding.

Further, in decoding, the encoded data in the respective blocks and the level specification signals of the respective pixels in the respective blocks written into the memory in the order of generation are read out in a scanning pattern which, according to cases, allows the data and signals to be rotated or inversely rotated an integral number of times 90°, so that it is possible to edit an image in decoding.

Claims

1. An image encoding method comprising the steps of:

    diving an original image into a plurality of blocks and setting representative gradation levels respectively representing the gradation levels of the respective pixels in each of said blocks;

    calculating reference levels for the respective blocks from the representative gradation levels of the respective pixels;

    setting level intervals obtained by classifying the distribution range of the representative gradation levels of the respective pixels in each of said blocks into a given number;

    creating level specification signals respectively indicating to which one of said set classes each of said representative gradation levels of said respective blocks belongs;

    encoding said reference level signals, level interval signals and level specification signals into data of a fixed length independently of one another; and

    calculating decoded pixel data from said reference level signals, level interval signals and level specification signals to decode said encoded data,

    when said reference levels and level intervals are calculated and when said decoded pixel data are calculated, there is performed an operation to round fractions to the nearest whole number to thereby arrange the calculated values as integral numbers.

2. An image encoding method as claimed in claim 1, wherein said operation to round fractions is one of a cut-off operation and a half-adjust operation.

3. An image encoding/decoding method comprising the steps of:

    dividing an original image into a plurality of blocks and setting representative gradation levels respectively representing the gradation levels of the respective pixels in each of said blocks;

    calculating reference levels for the respective blocks from the representative gradation levels of the respective pixels;

    setting level intervals obtained by classifying the distribution range of the representative gradation levels of the respective pixels in each of said blocks into a given number;

    creating level specification signals respectively indicating to which one of said set classes each of said representative gradation levels of said respective blocks belongs;

    encoding said reference level signals, level interval signals and level specification signals into data of a fixed length independently of one another; and

    calculating decoded pixel data from said reference level signals, level interval signals and level specification signals,

    when said encoded data in each of said blocks and said level specification signals of the respective pixels in each of said blocks are read out from said original image as pixel data, said data and signals are written into a memory in such a scanning order that they can be rotated or inversely rotated an integral of times 90° according to cases.

4. An image encoding/decoding method comprising the steps of:

    dividing an original image into a plurality of blocks and setting representative gradation levels respectively representing the gradation levels of the respective pixels in each of said blocks;

    calculating reference levels for the respective blocks from the representative gradation levels of the respective pixels;

    setting l vel intervals obtained by classifying the distribution range of the representative gradation levels of the respective pixels in each of said blocks into a given number;

    creating level specification signals respectively indicating to which one of said set classes each of

said representative gradation levels of said respective blocks belongs;

encoding said reference level signals, level interval signals and level specification signals into data of a fixed length independently of one another; and

calculating decoded pixel data from said reference level signals, level interval signals and level specification signals,

when said encoded data of said respective blocks and said level specification signals of the respective pixels in said respective blocks are read out from a memory in which said encoded data and said specification signals are written, they are read out in such a scanning order that they can be rotated or inversely rotated an integral number of times 90° according to cases.

FIG. 1

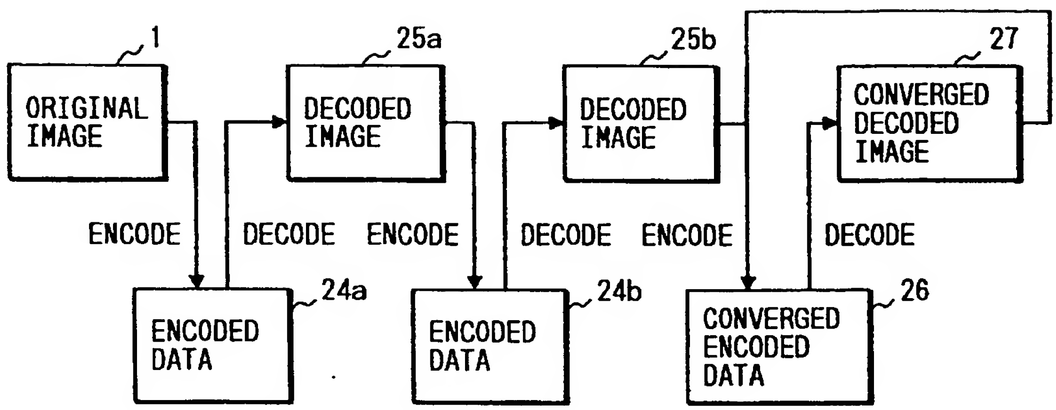

1
ORIGINAL IMAGE
25a
DECODED IMAGE
25b
DECODED IMAGE
27
CONVERGED DECODED IMAGE
ENCODE
DECODE
ENCODE
DECODE
ENCODE
DECODE
24a
ENCODED DATA
24b
ENCODED DATA
26
CONVERGED ENCODED DATA

FIG. 2

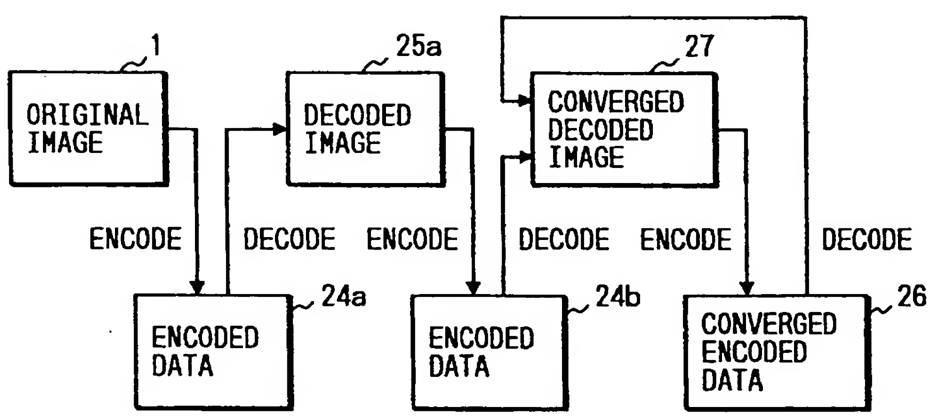

1
ORIGINAL IMAGE
25a
DECODED IMAGE
27
CONVERGED DECODED IMAGE
ENCODE
DECODE
ENCODE
DECODE
ENCODE
DECODE
24a
ENCODED DATA
24b
ENCODED DATA
26
CONVERGED ENCODED DATA

FIG. 3

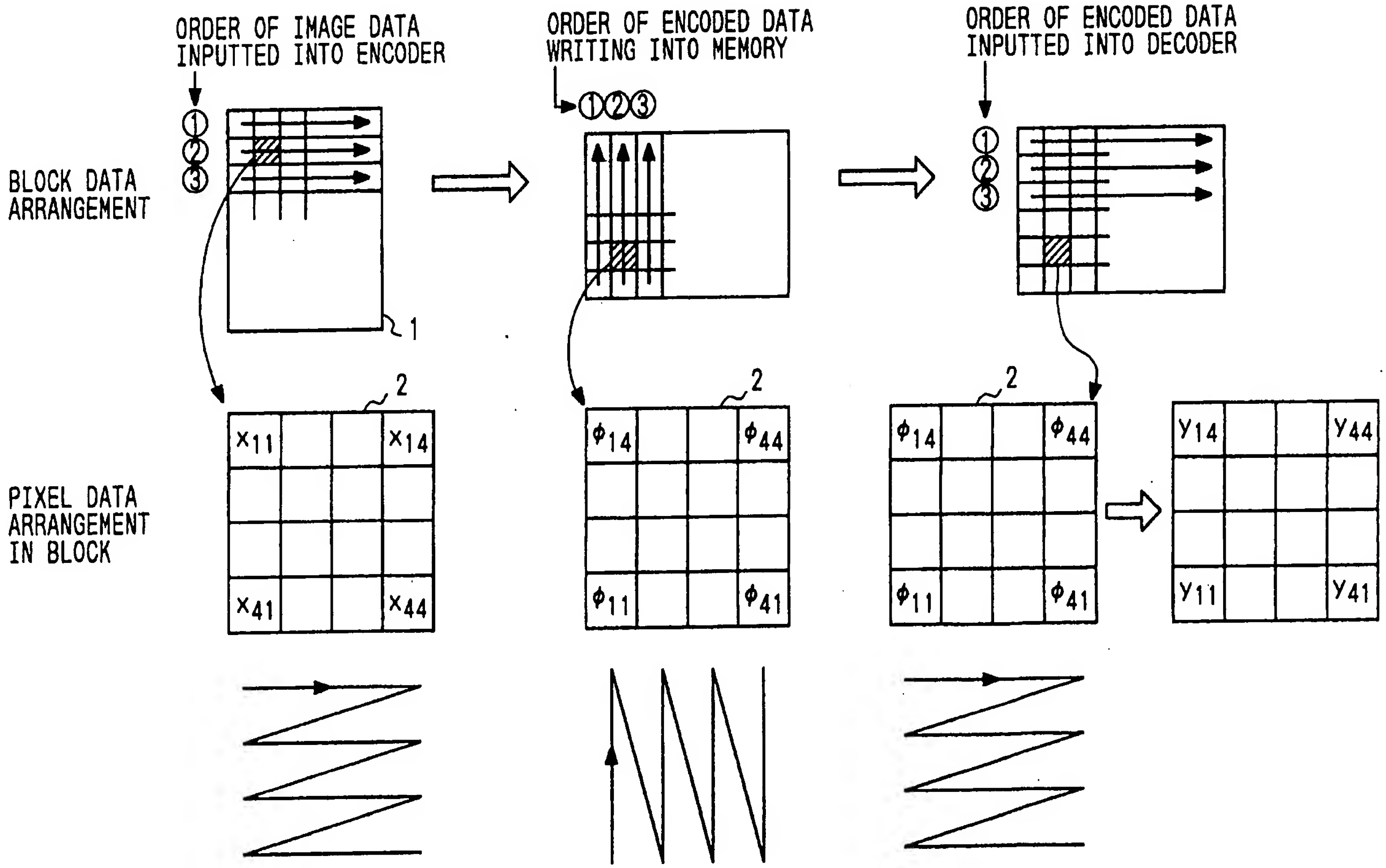
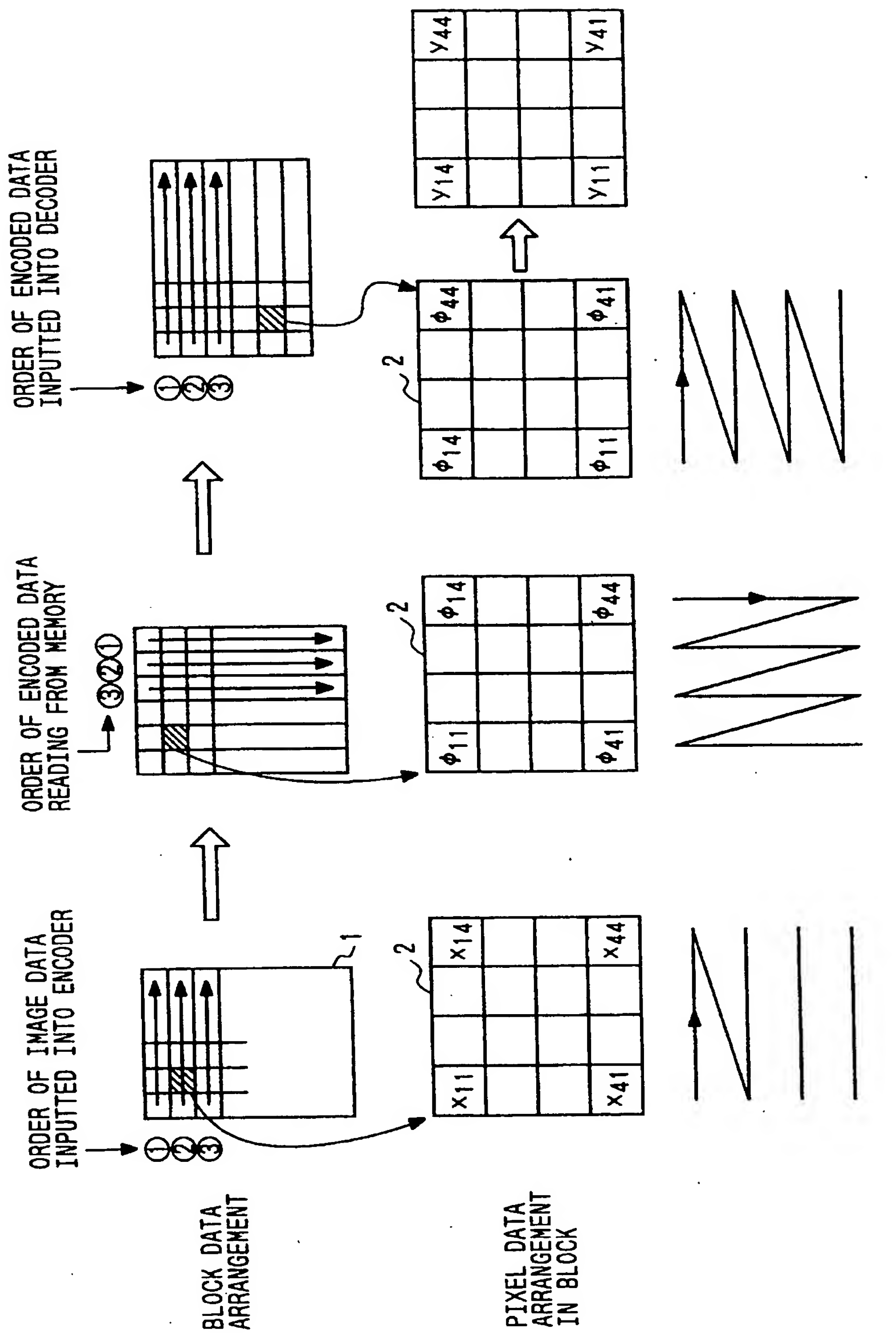

ORDER OF IMAGE DATA INPUTTED INTO ENCODER
ORDER OF ENCODED DATA WRITING INTO MEMORY
ORDER OF ENCODED DATA INPUTTED INTO DECODER
BLOCK DATA ARRANGEMENT
PIXEL DATA ARRANGEMENT IN BLOCK
1
2
①②③
x_{11}
x_{14}
x_{41}
x_{44}
ϕ_{14}
ϕ_{44}
ϕ_{11}
ϕ_{41}
y_{14}
y_{44}
y_{11}
y_{41}

FIG. 4



ORDER OF IMAGE DATA INPUTTED INTO ENCODER
ORDER OF ENCODED DATA READING FROM MEMORY
ORDER OF ENCODED DATA INPUTTED INTO DECODER
BLOCK DATA ARRANGEMENT
PIXEL DATA ARRANGEMENT IN BLOCK
①②③
③②①
1
2
X11
X14
X41
X44
φ11
φ14
φ41
φ44
Y11
Y14
Y41
Y44

FIG. 5

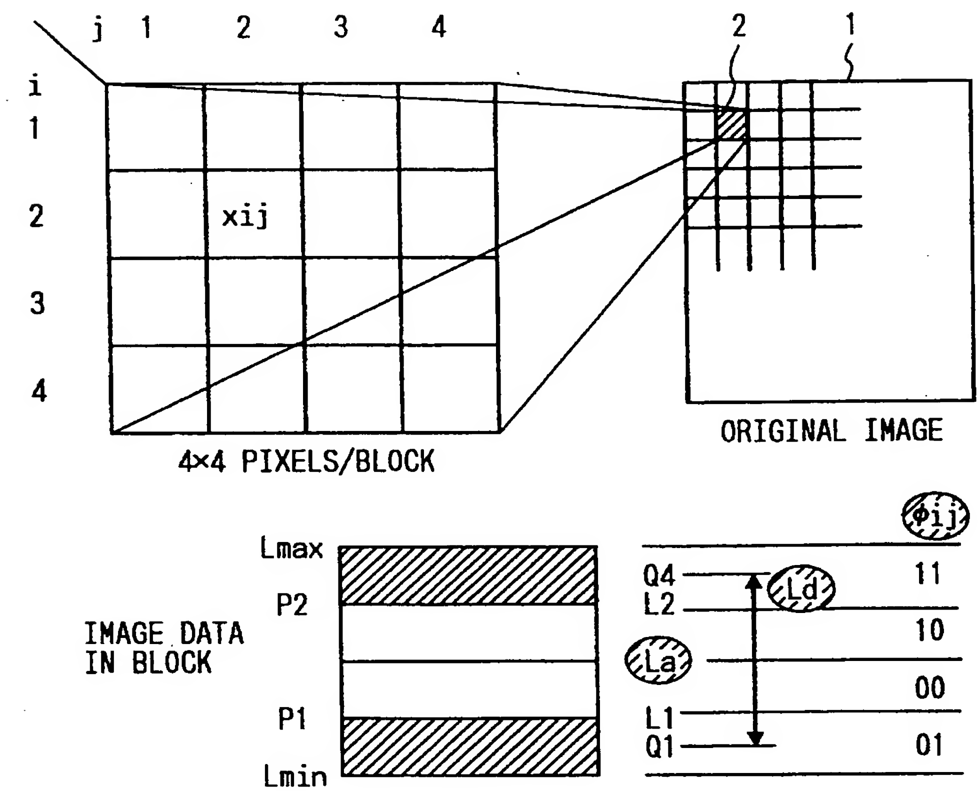

j
1
2
3
4
i
1
2
3
4
xij
4×4 PIXELS/BLOCK
2
1
ORIGINAL IMAGE
Lmax
P2
IMAGE DATA
IN BLOCK
P1
Lmin
Φij
Q4
L2
Ld
La
L1
Q1
11
10
00
01

FIG. 6

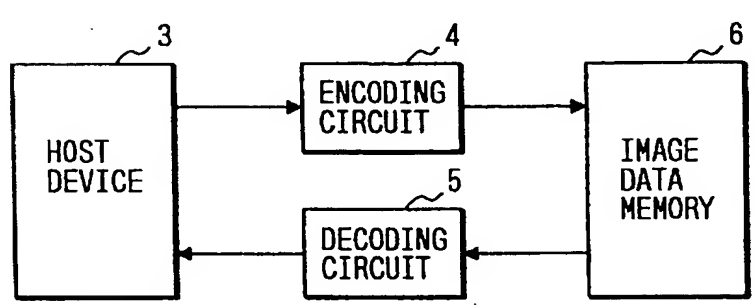

3
HOST
DEVICE
4
ENCODING
CIRCUIT
5
DECODING
CIRCUIT
6
IMAGE
DATA
MEMORY

FIG. 7

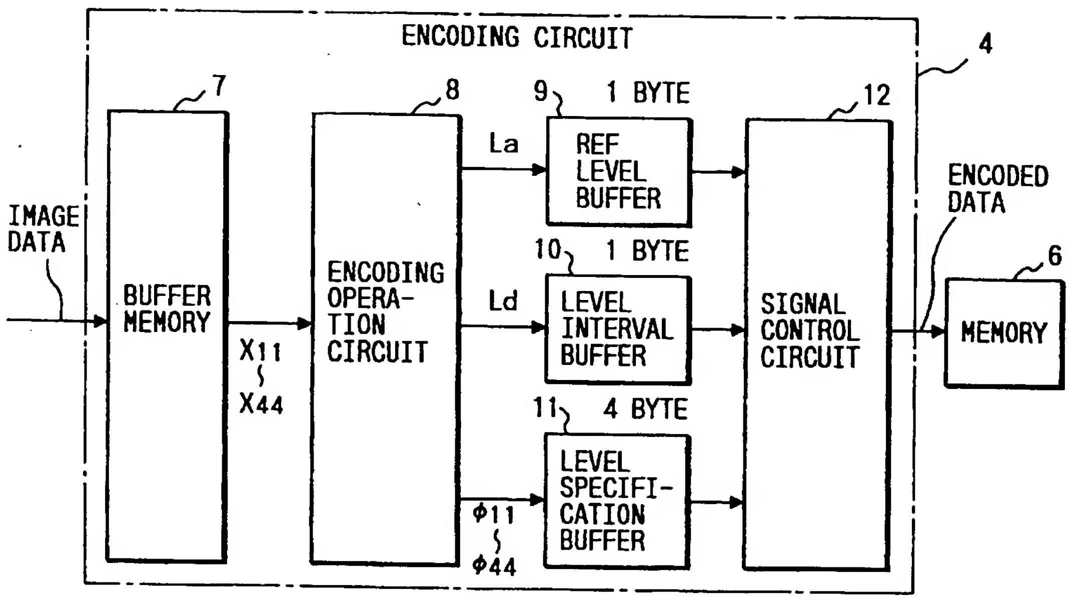

ENCODING CIRCUIT
4
IMAGE DATA
7
BUFFER MEMORY
X11
X44
8
ENCODING OPERA-TION CIRCUIT
La
Ld
ϕ11
ϕ44
9
1 BYTE
REF LEVEL BUFFER
10
1 BYTE
LEVEL INTERVAL BUFFER
11
4 BYTE
LEVEL SPECIFI-CATION BUFFER
12
SIGNAL CONTROL CIRCUIT
ENCODED DATA
6
MEMORY

FIG. 8

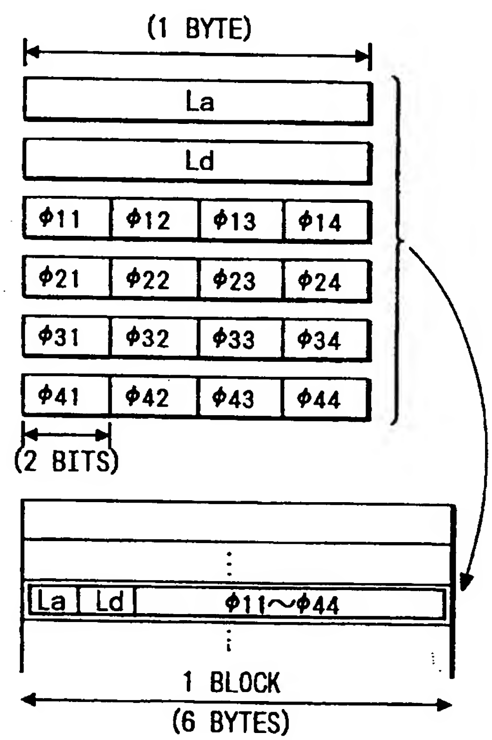

(1 BYTE)
La
Ld
ϕ11
ϕ12
ϕ13
ϕ14
ϕ21
ϕ22
ϕ23
ϕ24
ϕ31
ϕ32
ϕ33
ϕ34
ϕ41
ϕ42
ϕ43
ϕ44
(2 BITS)
La
Ld
ϕ11~ϕ44
1 BLOCK
(6 BYTES)

FIG. 9

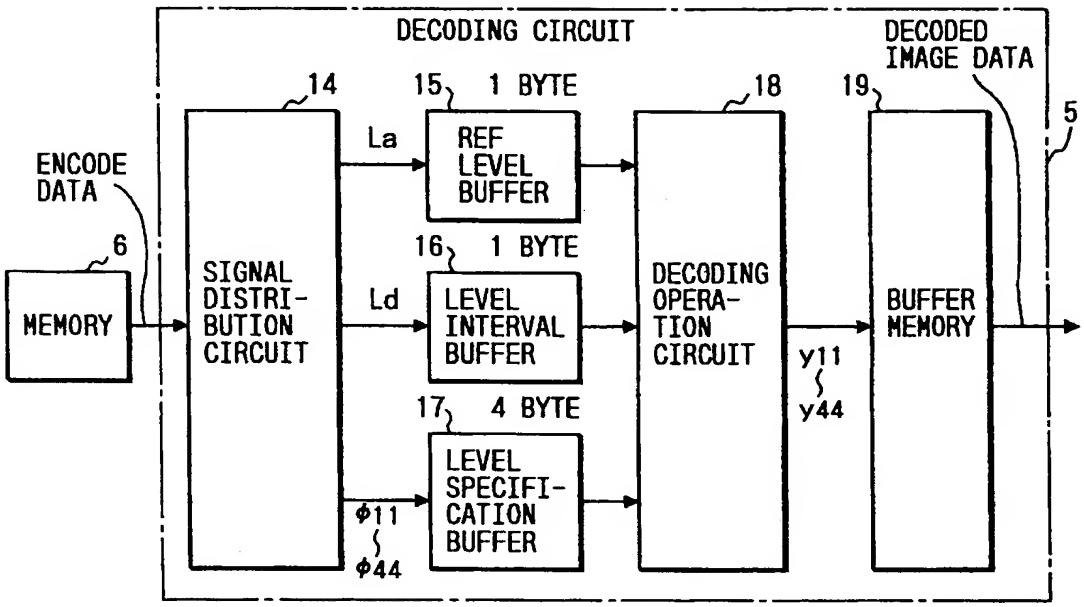
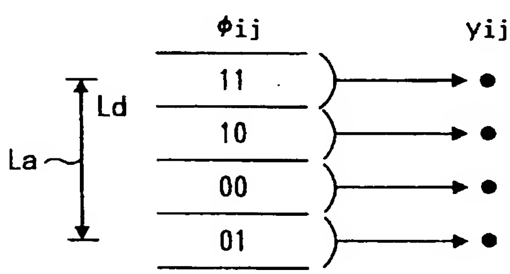

DECODING CIRCUIT
DECODED IMAGE DATA
ENCODE DATA
MEMORY
6
14
SIGNAL DISTRI-BUTION CIRCUIT
15
1 BYTE
La
REF LEVEL BUFFER
16
1 BYTE
Ld
LEVEL INTERVAL BUFFER
17
4 BYTE
LEVEL SPECIFI-CATION BUFFER
φ11
φ44
18
DECODING OPERA-TION CIRCUIT
y11
y44
19
BUFFER MEMORY
5

FIG. 10


φij
yij
11
10
00
01
Ld
La

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 3923

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y A	EP-A-0 261 561 (FREDERIKSEN & SHU LABORATORIES, INC.) 30 March 1988 * abstract; figures 2,3 * * column 6, line 36 - column 10, line 15 *	1,2 3,4	H04N1/41
D,Y A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 481 (E-838)31 October 1989 & JP-A-11 088 166 (NIPPON TELEGR & TELEPH CORP <NTT>) 27 July 1989 * abstract *	1,2 3,4	
P,A	EP-A-0 549 309 (XEROX CORPORATION) 30 June 1993 * abstract *	3,4	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)
H04N G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 February 1994	Revellio, H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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